THESIS
ON
DRAINAGE.
1881

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It may be truly said that upon agriculture depends all the other industries of the world and whatever tends to elevate and make the agriculture of the world better, tends just so much to lift the other industries, thereby producing more capital and consequently making the world richer. - To the general farmer no question is of more importance than the question of drainage. The farming of to day is not, and cannot be, what it was fifty or even twenty years ago. The time was when it seemed as though our western prairie lands could not be so abused but that it would produce abundant harvests. But that time has passed and the farmers of today are reaping the results in smaller harvests. Had they pursued a different course the amount of their harvests might have remained undiminished. -

Now what will bring our much abused land back to its former fertility? - The answer will probably be better cultivation and the addition of fertilizers. Both of these methods are expensive; one costing much labor and the other costing both labor and money. The general farmer has to do more work on his land to day than he did twenty years ago. -

Are there any helps which a farmer can obtain which will aid him in getting the best results from his labor and money he puts on his land in the shape of cultivation and fertilizers? Those who have studied the subject and seen the results, would answer drainage is such a help-

Drainage and its need will be especially spoken of in what follows.

Of the several kinds of drainage some will be but little more than mentioned, while others will be spoken of more at length. — Those that will be more particularly noticed will be natural drainage, open drains and closed drains or tile drains. -

One of the drains not generally used in this country is the brush drain. This drain is made by making the ditch a foot wide at the bottom, then laying in this poles four or five inches in diameter, so that there is an open space between them. Then lay in the brush, the coarsest at the bottom, filling the ditch nearly full, taking care that the but ends lay towards the direction from which the water flows, as it obstructs the water less when laid in this manner. Turf is then laid carefully on this. It should be made as compact as possible by treading. Brush drains will do well in some localities for perhaps ten years, but will in time become useless from filling up with sand, or from damage done them by field mice. — As a general rule it is not advisable to use this mode of drainage. —

The other mode of drainage is the mole drain. It is needless to speak of the method of making this kind of drain. In clayey soils this answers the purpose well for a time, but it is not durable. —

Shoulder drains and plug drains are not profitable modes of drainage

so they will be passed by. Where stone is plenty, drains are made in much the same way as the brush drains. Stones are used instead of brush but they have the same fault, often lasting only three or four years.—

All lands do not require drainage and those are those lands that naturally have enough slope to carry the water off or have a gravelly or sandy subsoil.—

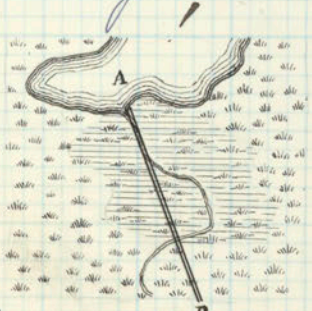
The practical farmer can tell very quickly whether his land requires drainage or not. If after a rain the ground does not become dry after a reasonable time has elapsed and little puddles remain standing in depressions on the surface, or if the furrow slice presents a greasy appearance when turned, or if the land becomes baked and hard in the summer, or the crops have a stunted appearance, or water grasses are found growing, these signs and others show that the natural drainage of the land is not enough, and that some artificial drainage must be done.—

The mode that would naturally be followed would be open ditches. In these days when drainage is deservedly coming to have such good repute, the open ditch is getting to be almost a thing of the past. But in some cases the open ditch is the best method of drainage. For instance in low, boggy, very springy land, where the muck is from ten to twelve feet deep, a larger open ditch would be the best mode of drainage.

In such a soil tiles cannot be easily laid, owing to the amount of water and the nature of the soil. Tiles become misplaced and filled up and after a time become useless. Where land is subject to frequent overflows from sudden rising of streams, a good open ditch is best.—

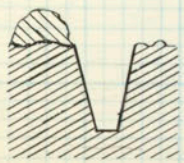
Generally open ditches are but aids to natural drainage, the surface of the soil only being thoroughly drained, not draining the soil just under the surface well enough but so that in dry times the soil will be liable to bake and injure the crop if the land be cultivated.—

By means of an open ditch a stream can be straightened thereby making more land and draining at the same time.—



As in figure 1 it is much better to have the water take the straight course from A. to B. than to follow the natural course of the stream.—

One fault of the open ditches is their tendency to fill up. This fault can be remedied by making the ditch properly. Generally the way of the open ditches have been made is to make them from two to four feet wide at the top, sloping gradually down to the bottom, leaving the dirt piled up at the side as shown in figure 2. Where the dirt is piled up as represented it is very detrimental to the ditch, as it makes a pressure on that side and also serves as a dam keeping the water out of the ditch.



Another fault with this ditch is that the sides do not have

slope enough. The action of frosts and water breaks down the sides in a little while and the ditch becomes useless.

The correct way to make an open ditch is to make it wide and deep and in the form of a curve instead of two slopes. Usually the ditch should be at least twelve feet wide and not less than six feet deep. The dirt should not be left near the edge of the ditch but should be taken away or shoved be put into piles at intervals some distance from the edge of the ditch

Figure 3

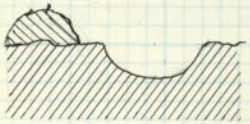


Figure 3 represents a ditch made correctly. Wherever possible a team and scraper may be used and facilitate the work of opening the ditch. Ditches made in this way are not so apt to fill up by caving of the sides, be cause the slope of the sides is more gradual. The dirt being put into piles allows the water to run into the ditch instead of being holed and running that side of the ditch.

But the method of draining that is the most important to the western farmer is the tile drain, or closed drain. Of the history of tile drainage but little will be said and that will pertain especially to our own state (Ill.) Tile drains have been known and used for years in this country, but until within the last five years tile drainage was almost a thing unknown to the mass of the farmers in this state. Now there is hardly a farm but has more or less tile drainage done upon it

Five years ago there were perhaps perhaps five tile factories in Illinois: now there are at least one hundred and fifty; and all of them find ready sale for all the tile they can manufacture.—

Of all the modes of drainage that by means of tile is the best and the most practical. In laying tile drains the first thing to decide is where to lay them to do the most good. The mains should be laid so as to follow the general direction of the water course. Sharp bends should be avoided. If the general water course in the piece of land drained should make a sharp bend it would be better to cut across and keep the line straight rather than to go around and make the bend.—

The land will be almost or quite as well drained and the tile can be laid better. Before laying a line of tile one should be certain of a good out let for upon this depends the success of tile drainage. This outlet should be well protected by plank or better still by stone or brick.

The fall should be determined as nearly as possible. Too much fall being nearly as detrimental as too little. There should be if possible between three and twelve inches to the hundred feet. If great care is taken very little fall will answer the purpose. To ascertain this fall some sort of level should be used. There are many kinds that may be used, besides those used by engineers and for all practical purposes answer the purpose just as well. The level will be considered further on.—

Theoretically speaking the deeper the tile is laid the wider will be the space drained. That this is so will be readily seen. For instance, say the tile is laid to the depth of three feet, at first the strip drained will be comparatively narrow, then it will be noticed that the soil will be drained to a greater distance until at last the effects cease to be noticed. It seems that water forms courses towards the line of tile and these courses extend wider and wider. The farmer should be guided by his own judgment as to the depth he should lay his tile, there being many things to be considered, such as the nature of the soil whether clayey, sandy or muck, whether the land is to be cultivated or not. — In all cases the tile should be laid below the action of the frost and deep enough so they will not be disturbed by the farming implements. — It is the best plan to begin digging the ditch and laying the tile from the outlet, then the water will have a chance to run away and will also be an aid in showing directly the fall, and also an aid in showing any inequalities in the bottom of the ditch. The joints should be made as tight as possible. Sometimes just turning the tile the other side up or the other end to will make a joint very much better. The fall of each tile should always be the same way, this can be ascertained by laying a mason's level on the tile every once in three or four feet. These little points should be well attended to as upon them

depends the success of the tile drain. If in laying tile the fall is changed, it should change from a less to a greater, rather than from a greater to a less. In figure 4 and 5 A.B.C and a.b.c represent the lines of tile.

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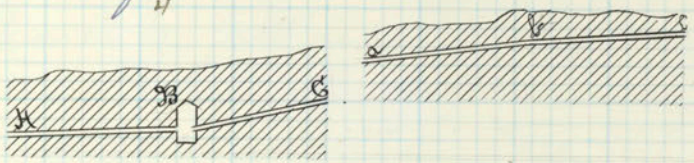

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In all lines of tile there is more or less of sediment or silt as it is called. Now when the fall is changed from a greater to a less fall as in figure 4 this silt tends to settle and choke the tile. But if as in figure 5. the fall is from a less to a greater, the silt will have no chance to settle. In figure 4 a silt basin should be placed at B. —

Silt basins are chambers made brick, or sometimes a large tile stood on one end into which the water of a tile drain flows, becomes quiet for a while, the silt settling to the bottom, instead of being carried on to settle in the tile. The bottom of the silt basin should be considerably lower than the bottom of the tile and the out let from the basin should be above the inlet as much as the fall and the depth of the drain will allow. These basins can be cleaned out from time to time. The amount of silt will depend upon the nature of the soil drained, clays having less silt than other kinds of soil. —

When it is necessary to branch a tile drain or to lay laterals, branch tile should be procured or a silt basin made at the junction.

A very good branch can be made by making a notch in the side of a tile with a hatchet or some other instrument and fitting the end of another tile into it, in this way as good joints can be made as between the ends of the tile, by a little practice. Laterals should be laid directly up and down the slope for reasons that are obvious. - When the land drained is liable to wet or springy at times, it is well to have the upper end of the line of tile begin in a well or silt basin for the water to gather the water for some considerable distance around. -

The next point is the size of tile. Here again the farmer must follow his own judgement. A tile should be large enough to carry off all the water, but the amount of water varies. At times one size of tile would easily carry all the water; at another a tile of twice that diameter will be found insufficient to carry the water as after a heavy rain. The farmer has to make allowances for all these variations. As a general rule no tile should be laid less than three inches in diameter and in most cases four and five inch tile should be laid. In treatises on drainage tables are made showing the size of tile to be used. These are helps, but nothing definite can be ascertained and but little reliance can be placed in them. The smoothness, rate of fall, nature of soil, and depth of

of the tile all effecting amount of flow.-

The majority of the farmers cannot afford to do much thorough drainage and in fact it will not pay for the average farmer to do thorough drainage. The best plan is to drain those places that need drainage most first, then do as much more drainage as he thinks profitable. It is best to keep in view the idea of thorough drainage. In most of our farming soils fifty feet apart is near enough to lay drains.—

kinds of tile.- Theoretically the oval shape tile is the best shape for they will stand the pressure of the soil better than other shape. But every thing taken into consideration the round tile, made of brick clay, are the best. Horse shoe tile are apt to be crushed in by pressure, thus ruining the drain. These should not be used on that account. The solid tile are better than the horse-shoe tile but are apt to warp in burning and are objectionable on that account.

A tile should have a smooth bore; ends square and smooth cut as possible and be free from cracks and flaws.—

The porocity of the tile has nothing to do with their use as far as to their draining capacity, the water entering at the joints and from below. - That water enters from below can be readily seen. In all soils there is what is called a line of permanent saturation. This line varies with the seasons, being higher sometimes than at others.

Now tile drains lower this line down to the bottom of the tile.
Rains may raise this line but the water will soon be carried off and the line will be lowered to its former position.—

Effects of tile drainage on the soil.— It increases the depth of the soil. The air takes the place of the surplus water. Chemical action takes place thereby making the whole depth of drained soil a home for plant roots. Corn roots have been known to penetrate a well drained sandy soil six, eight and ten feet. Drainage warms the soil. No heat is absorbed by wet soil until the water at the surface has been changed to vapor, thereby taking up heat that would otherwise be taken up by the soil. Drained soil is found to be from six to ten degrees warmer, at seven inches below the surface, than undrained soil. Heat is an important chemical agent. By means of heat matters contained in the soil become decomposed and, mingling with other matters, make the soil deeper and better. It is better to have the water run through the soil than to have it run over, as in the case of open ditches, for then the atmospheric plant food as ammonia &c. washed down by the rain is taken up and held by the drained soil.—

In dry times soil below the surface is much cooler than the air and therefore it absorbs the moisture that is in the air and

we see that drained soil is better enabled to stand a drouth. In undrained land the soil becomes baked, giving but little range for the roots while drained soil remains mellow giving a greater range for the roots.—

Tools.—The tools needed are a spade, shovel, scoop, level, and for sticky soils a wooden spade. A good level can be made by taking a mason's level, placing it on a tripod. Upon this are placed two sights and a leveling screw. Leveling can be done with this level accurately enough for all practical purposes. By placing the level upon a narrow board of about the same length and which is connected with the tripod by a pivot so that it may be turned in any direction. The spade and shovel are such as can be bought at the hardware stores. The wooden spade can be made out of any hardwood as ash or oak. The scoop can be made by any blacksmith. It should be hollowing and need to finish up the bottom of the ditch.

Cost of Tile. Tile can be bought at the following prices at most of the tile factories

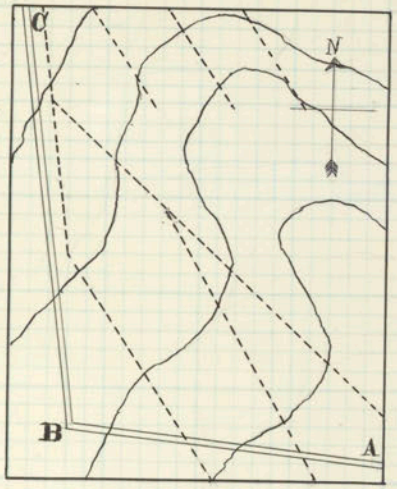
Three inch tile	$15.00 per 1000.—	Six inch tile	$45.00 per 1000.—
Four " "	25.00 " "	Seven " "	60.00 " "
Five " "	35.00 " "	Eight " "	75.00 " "

According to reports of manufacturers more three and four inch tile are sold than of other sizes.

Does it pay to tile drain? Take for instance a small slough that extends through a field say for sixty rods. The soil in these sloughs is too wet to be tilled in the spring and during the rest of the year is dry and baked and will not produce any thing. There are thousands of just such instances in the farms of the west. Say the slough is three rods wide. The use of an acre of land is lost. A line of three inch tile will drain this, costing perhaps $25.00, labor and all. We see that one years crop of corn at 50 bushels per acre and 40¢ per bushel will nearly pay for the tile. Besides we have done away with the bother of such a slough and we have the use of the land, which was before of no value, now becomes the best land in the field. —

Farmers should keep a plat or map of all tile laid. This may not be very elaborate but should be sufficient to tell where the tile is. —

Sometimes money and labor may be saved by taking advantage of the lay of the land &c. Suppose we have 4 fields liable to become wet from water flow fields above, which is often the case. A good example being the field just south East of the S. S. W. Let this field be represented by a figure



The land slopes to the north west. The water coming from the south and south east. Now instead of running tiles as represented by the dotted lines; we run a line of large tile as represented by A. B. C. We do the same work as the other lines of tile do and save all the extra labor and expense of putting in the extra lines of tile.

Tile drainage is one of the greatest helps the western farmer has. for by it larger and better crops are produced.

Surely the words of him who said that "He who causes two blades of grass to grow where but one grew before is a public benefactor" are true.